



Heat Transfer in Liquid Surface PFCs ALPS Heat Transfer Group

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- **Work on Li handling for ALIST is primary activity. Should we be studying other applications? - Scope should be reexamined, e.g., attention to thermal penetration by ELMs ($1.2\text{MJ}/100\mu\text{s}=12\text{GW}/\text{m}^2$).**
- **APEX Task III will probably resume exploration of a Sn or Ga first wall and divertor in FY2003. Data on the properties, e.g., thermal conductivity, of Sn well above the melt temperatures are scant. This was identified early as a need but no work was undertaken.**
- **CFD2000, our commercial CFD code, can assign a heat flux to a fluid surface (with no MHD effects), and has been used for simple cases of round and flat Li streams.**

Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.



Sandia Liquid Metal Heat Transfer Tasks

- Li loop is assembled.
- Li ingots have been melted and transferred into the furnace chamber.
- Permanent magnets have been mounted on an iron yolk to simulate NSTX fields.
- An unplanned Li fire provided practical information on Li fires and the responses of emergency teams.
- Several CFD2000 code cases have been run with heated Li streams, but it is cumbersome.



furnace



transfer tank



*Li
transfer
station*



*flanges,
insulation
and Lithex
after fire*



*transfer tank
and furnace*

ITER+IFMIF+CTF → DEMO

*How does “fast track” affect planning for
the ALPS Heat Transfer Task?*

Let us accept that:

- (1) liquid surface chamber designs are attractive for a DEMO and**
- (2) CTF is available to develop liquid metal divertors.**

- Some engineering of a liquid surface divertor for DEMO may be done in CTF but the development path may also require deployment of a liquid divertor module to demonstrate heat removal in a fusion experiment with a strong magnetic.**
- ALIST tasks for NSTX are needed for other reasons and do not meet this objective.**

Liquid Surface divertors in fusion reactors

High pumping (e.g., recycling $<10\%$) by a LS would greatly affect particle control. Impurities as well as D/T may be trapped. Edge temperatures may be high. Fast fueling may be an important issue.

Some diverted plasma and a target will be needed to reduce the interaction of impurities with the core (sweep the edge) or to accept high particle loads (heat sink) or both.

- *We will need a divertor/target to control particle exhaust or heat loads.*
- *Integration of a divertor/target into the design of a solid or liquid wall concept is an important part of the development of such concepts*

Is there a “best basic” PFC, or does the selection of PFC technology (e.g., droplets versus flowing films) vary with the concept?

How constrained by hardware (Dewar, blanket, ports) is the PFC?

What are the heat loads ($q_{||}$ and flux expansion)?

Does a single null divertor work well in this concept?

Notes from Snowmass99

Readiness and Innovation in Technology

Richard Nygren and Sam Berk (white paper, 1999)

.. goals of technology R&D ... themes of **innovation and readiness**.

... tension between near term goals and long term goals

Hardware is needed for new and ongoing projects. And we must demonstrate a sound nuclear technology for fusion reactors at some point to give credibility to the program's goals. ...

Be ready! .. strong influence on the fusion program of external events, such as the oil embargo of the 1980's... *[Bob Conn, Snowmass99]*

...examples of "readiness" in fusion technology are

(1) the preparation for D-T shots in TFTR and

(2) .. the ITER divertor

.. combined efforts in science and engineering
and in physics and technology.

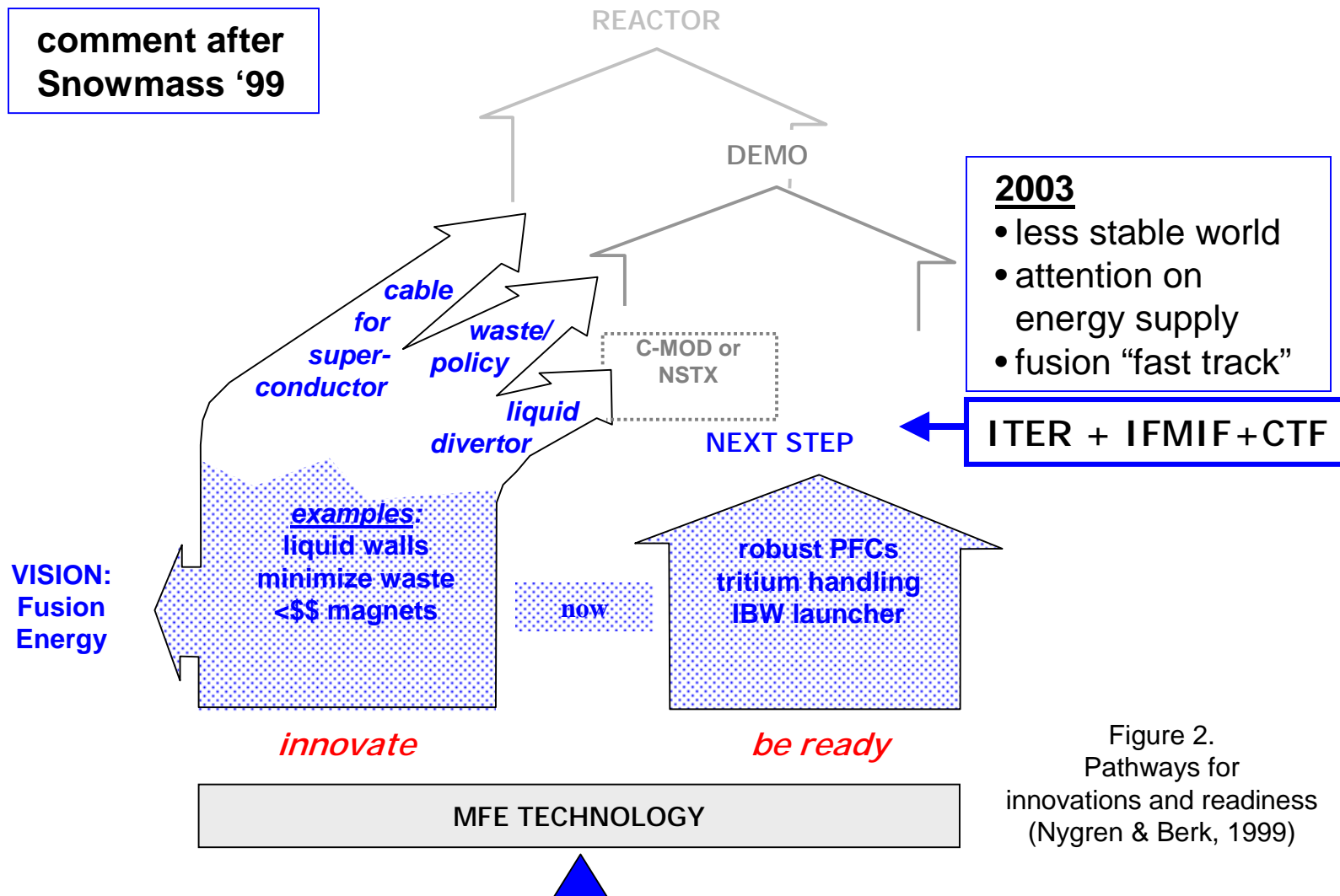


Figure 2.
Pathways for
innovations and readiness
(Nygren & Berk, 1999)